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REPORT

MRL-R-731

MARINE FOULING AT HMAS STIRLING WA

OCTOBER 1976 - APRIL 1978

Ian C. Dunstan

Approved for Public Release

OCTOBER, 1978

LEVEL II

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ABSTRACT

This report details the results of a study of marine fouling at HMAS STIRLING in Careening Bay, Western Australia. Non-toxic panels were immersed for varying times below Submarine Wharf between October 1976 and April 1978. The identity and seasonal variation in settlement of fouling species were determined. Community development was primarily dependent upon the temporal sequence of settlement and growth of organisms, although one example of biotic succession was noted. The marine fouling in Careening Bay was compared to fouling communities at Naval establishments on the eastern coast of Australia.

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16. ABSTRACT (If this is security classified, the announcement of this report will be similarly classified):

This report details the results of a study of marine fouling at HMAS STIRLING in Careening Bay, Western Australia. Non-toxic panels were immersed for varying times below Submarine Wharf between October 1976 and April 1978. The identity and seasonal variation in settlement of fouling species were determined. Community development was primarily dependent upon the temporal sequence of settlement and growth of organisms, although one example of biotic succession was noted. The marine fouling in Careening Bay was compared to fouling communities at Naval establishments on the eastern coast of Australia.

CONTENTS

MARINE FOULING AT HMAS STIRLING WA

OCTOBER 1976 - APRIL 1978

1.0 INTRODUCTION

Marine fouling is the assemblage of marine organisms that attach to, and grow upon, underwater objects. Buoys, wharf piles, ship hulls, underwater cables and conduits suffer reduced efficiency due to the growth of sessile plants and animals which constitute marine fouling communities. Fouling also reduces the efficiency of underwater listening devices and affects the hydrodynamic character of sonar domes resulting in an increase in water noise.

The character and intensity of marine fouling varies greatly with geographic, environmental and seasonal factors (De Palma, 1963). Consequently, measures which effectively inhibit or reduce fouling growth in one harbour may not have the same effect in another location. A detailed biological program to determine the characteristics of fouling is essential to ascertain whether measures need to be taken to protect underwater equipment, and to determine how long equipment will remain functional if protective measures cannot be taken. Similarly, assessment of the efficiency of anti-fouling coatings in a specific region cannot be made without first knowing the patterns of settlement and development of the marine fouling community for that area (Mawatari, 1967).

Until recently, information on marine fouling in Australian waters was restricted to studies in Sydney Harbour (Allen and Wood, 1950; Wood, 1950; Wood and Allen, 1958; Wisely, 1959). An increased awareness of the need for information from other regions has led to reports on the marine fouling in Tropical North Queensland (Garret and Ledbury, 1974; Zann, 1975; Garret, 1976), Williamstown Naval Dockyard, Victoria, and Garden Island Naval Dockyard, New South Wales, (Russ, 1977), and Careening Bay, Western Australia (Fremantle Port Authority, 1970-1974). Ongoing projects include a study of fouling in Port Phillip Bay, Victoria (Heated Effluent Study Group, 1973) and Careening Bay, Western Australia (Chalmers, personal communication).

The Marine Environment Group is conducting a research programme to characterise and compare the marine fouling at a number of sites of Naval interest around the Australian coast. These sites are located near

Innisfail, North Queensland, at Christmas Island in the Indian Ocean, Williamstown Naval Dockyard, Victoria and at the recently constructed Naval Support Facility HMAS STIRLING in Careening Bay, Western Australia.

This report details the results from a study of the marine fouling at the HMAS STIRLING site. The study provides information on the seasonal variation in settlement and the development of the fouling community.

Little previous information exists on fouling along the West Australian coast. As part of an investigation into the Cockburn Sound ecosystem (Fremantle Port Authority,1970-1974) the growth of fouling was surveyed on the Garden Island Causeway, which runs adjacent to Careening Bay. While this study yielded information on the composition of the mature communities in the region, it did not supply data on the seasonal variation in settlement of organisms, or on the early developmental stages of the fouling community.

This report is intended to be of practical use to persons attempting to maximise the performance of underwater equipment utilised in the course of naval activity. It will also add vital biological data to the overall study of the Cockburn Sound region.

2.0 METHODS

2.1 Exposure Site

Experimental panels were immersed for fixed times on a frame suspended three metres below the Submarine Wharf at HMAS STIRLING in Careening Bay (Fig. 1). Due to shading by the wharf, the frame received 20% sunlight during maximum daylight hours. Conditions in Careening Bay are marine (Pettis, to be published).

2.2 Immersion Sequence

Black, unplasticised polyvinylchloride (PVC) panels, measuring 15 cm x 30 cm, were sandblasted to produce a dull surface and weighed before immersion. Plastic numbers were attached to each panel for identification.

During the first twelve months of the trial (October 1976 to October 1977) four series of panels were exposed. The first, designated the J-series, consisted of twelve panels, each being immersed for one month. This series yielded information on seasonal settlement patterns of fouling organisms. The second series, designated the Y-series, consisted of four panels which were successively immersed for three-month periods to supply data on the slower settling species which would not be detected on the one-month panels. The third, the X-series, consisted of twelve panels which were all immersed at the commencement of the trial, and removed at one-month intervals. The aim of this series was to document the changes which take place during the development of the fouling community.

The fourth series, the A-series, consisted of panels which were immersed at the start of the program (October 1976). The first of these panels was removed after fourteen months immersion, and the remainder at successive

two-month intervals. The aim of this series was to generate information on the longer term development of the fouling community.

At the end of the first twelve months of the trial, October 1977, a second immersion series of one-month replacement panels, the S-series, was implemented to follow on from the J-series. Four community development panels were also immersed at that time to be removed at three-monthly intervals.

Upon removal from the frame, the panels were preserved with formalin and returned to the Materials Research Laboratories for analysis.

2.3 Analysis of Panels

The following laboratory methods were used to analyse the fouling on the panels :

(i) The front and back of the panel were photographed.

(ii) All species on the panels were identified using a binocular dissecting microscope, magnification range x6 to x40.

(iii) Species densities were assessed by either individual or colony counts. Counts were made of every individual or colony of each species which occurred within two 13 cm x 3 cm transects situated 7 cm from the top and bottom of the panel (Fig. 2). A 1 cm strip around the edge of the panel was not assessed to remove possible anomalies towards the edge of the panel. Species density was expressed as the number of individuals or colonies per 0.01 m^2.

(iv) Large spreading colonies could not be assessed satisfactorily by the measurement of species density. For these species, the percentage cover was measured using a 0.5 cm grid over a 24 cm x 13 cm area of the panel. The number of intercepts of each species with the grid was recorded.

(v) The wet and dry (panel oven-dried at 80°C to a constant weight), weight of fouling on the panels were measured. The biomass of the prominent organisms on the panels were also recorded.

Density counts and cover were assessed separately for the back and front of the panels. Reported numerical values for these parameters are averages of the values from the two sides.

3.0 RESULTS

3.1 General

The periods of immersion of the panels analysed for this report are shown in Figure 3. Panels J1, J2, J3 and X1 were lost in transit from HMAS STIRLING. Panel Y1 was immersed for a month longer than scheduled; hence Y2 was only immersed for two months.

Eighty-four animal species were collected on the panels examined. These are listed in Table 1. Sixty-five were sessile species and nineteen were errant or free-moving organisms. No alga was collected on the panels.

The major fouling organisms at the Careening Bay site, as well as those in Hobson's Bay, Victoria and Garden Island, New South Wales (from Russ, 1977), are listed in Table 2.

The average monthly surface water temperatures for Cockburn Sound are shown in Figure 4. The connected values are an average of temperatures recorded for 1960, 1961 and 1963 at the Kwinana Refinery (Wilson and Hodgkin, 1967). Supplementary points are those temperatures recorded at HMAS STIRLING during 1977 (Pettis, to be published).

3.2 Seasonal Settlement Series

3.2.1 One-month replacement panels: February 1977 to April 1978

The monthly intensities of settlement of the prominent animal fouling species at HMAS STIRLING are illustrated in Figure 6. The total numbers of species found on each monthly panel are shown in Figure 5.

3.2.2 Three-month replacement panels: October 1976 to October 1977

The abundances of the prominent organisms found on the three-month immersion panels are shown in Table 3. The sum of abundances of these species on the corresponding one-month immersion panels are also tabulated.

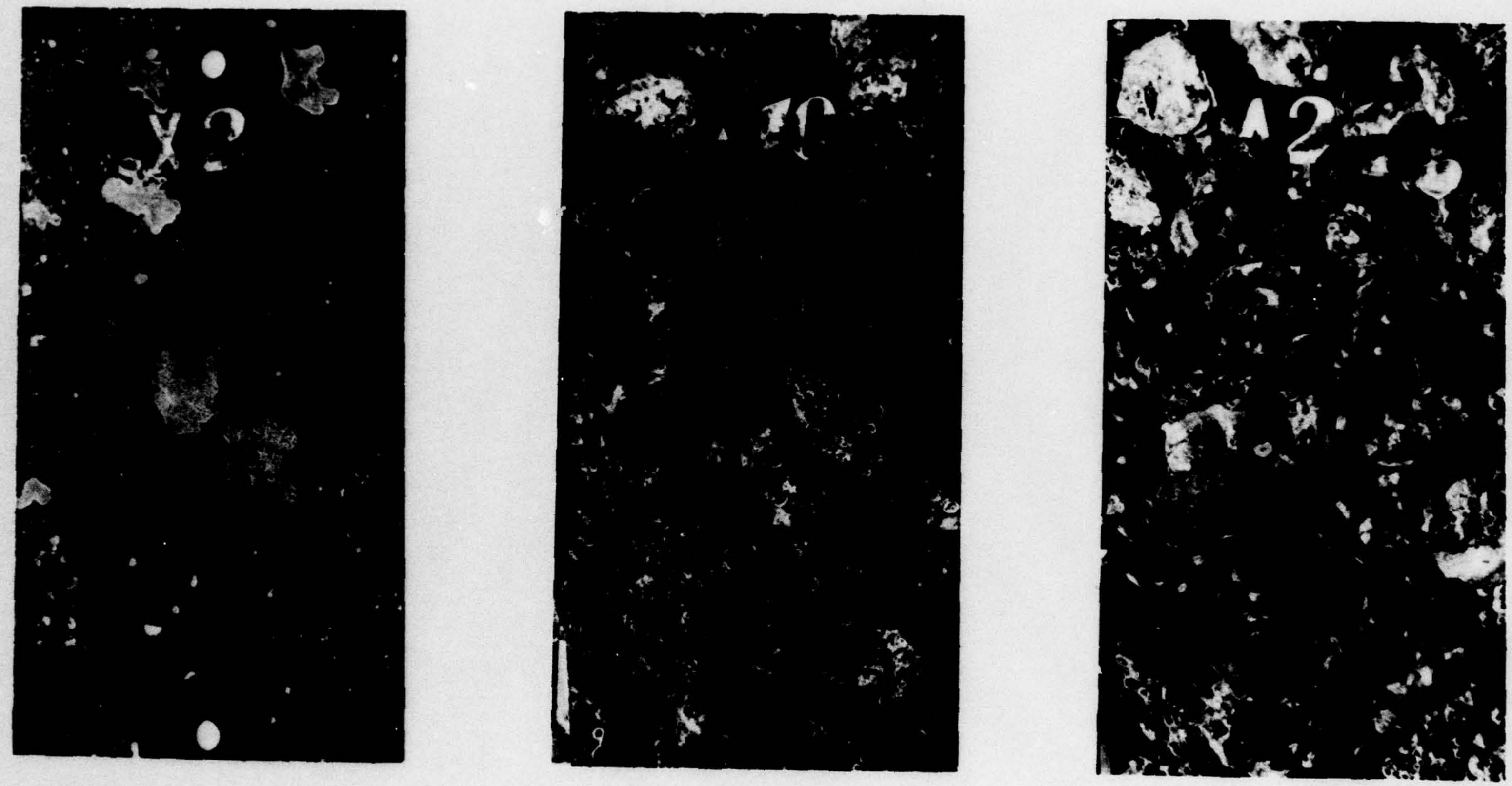
Four species were recorded on the three-month replacement panels that were not observed on the monthly immersion panels or community development series. These are indicated in Table 1.

3.3 Community Development Series

3.3.1 October 1976 to April 1978

The changes in abundances with time of the prominent animal fouling species are shown in Figure 7. Photographs of the fouling communities on the panels immersed for two, ten and sixteen months are presented in Plate 1.

The tubeworm *Spirorbis* sp. (Fig. 7a) and several compound ascidians, including *Trididemnum* sp. (Fig. 7b), exhibited heavy settlement on the freshly immersed fouling panels. This was followed by a large influx of the barnacle, *Balanus trigonus* (Fig. 7c) and tubeworm *Salmacina dysteri* (Fig. 7d) during late summer/early autumn (Plate 1a).



(a) 2 months (b) 10 months (c) 16 months

PLATE 1 - Development of the Marine Fouling Community at HMAS STIRLING.

Throughout winter, recruitment of sessile species was reduced (Fig. 8) and changes to the community were brought about by the increasing prominence of slow growing forms which settled during autumn. The jingle shell, *Anomia descripta*, the erect bryozoa *Tricellaria* sp. and *Bugula stolonifera*, the solitary ascidian *Microcosmus* sp. and the encrusting bryozoan *Rhamphostomella* sp. grew over the early colonisers and eventually dominated the panels (Plate 1b). An example of the growth of the sedentary forms is shown by the increase in the weight of the mollusc, *Anomia descripta* (Fig. 9). The mussel, *Mytilus edulis* settled in large numbers in late winter (Fig. 7e).

The number of errant species increased with the size of the fouling community. Errant species were generally found in low abundances and did not contribute greatly to the biomass of fouling. By late spring, the number of sedentary and errant species had stabilised at around thirty-four per panel (Fig. 8).

In October, a major change to the community occurred as the mussel, *Mytilus edulis*, grew to cover large areas of the panel (Plate 1c). The growth was reflected by an increase in dry weight of individual mussels (Fig. 10). The number of mussels found on the panels fell during the same period (Fig. 10).

During summer a resurgence of many species occurred as the spat of these organisms settled on the surface of the *Mytilus* and *Anomia* sp. The increase in settlement was pronounced for *Balanus trigonus* (Fig. 7c) and *Spirorbis* sp. (Fig. 7a). Most species then exhibited a drop in abundance on the eighteen-month panel (Fig. 7).

The fouling community present on the panels after eighteen months immersion was consequently dominated by *Mytilus edulis*, although several large *Anomia descripta* and ascidian individuals persisted. Many small species had settled on these larger organisms in the intense settlement period during summer.

The biomass of fouling after eighteen months immersion at HMAS STIRLING and twelve months at Williamstown Naval Dockyard, Victoria, and Garden Island Dockyard, New South Wales (Russ, 1977), are illustrated in Figure 11.

3.3.2 October 1977 to April 1978

After six months immersion, the composition of the fouling community on the community development panels immersed in October 1977 resembled that observed for the corresponding period the previous year (Fig. 7). There was however a marked increase in the abundance of the jungle shell, *Anomia descripta* (Fig. 7e). After six months' immersion the greater abundance of this organism resulted in a much larger community biomass than that recorded in Careening Bay for the same period the previous year (Fig. 11).

4.0 DISCUSSION

4.1 Seasonal Variation in Settlement

4.1.1 One-month immersion panels

The animal species collected during this program showed marked seasonal variations in settlement. The heavy settlement period coincided with the warmer temperatures of Summer/Autumn. Summer settlement is typical of temperate fouling sites (Russ, 1977) with the reproduction of many organisms completely suppressed in the winter period (Woods Hole Oceanographic Institute, 1952).

Balanus trigonus and *Trididemnum* sp. settled throughout the year but settlement was reduced during the colder months (Fig. 6). Skerman (1958) attributed peaks in the settlement of the barnacle *Elminius modestus* to periodic increases in the survival of the free living nauplius stage, which was primarily dependent upon food availability. Nauplius survival, which would have led to an increased number of spat that achieved sessile status, may have similarly controlled settlement rates for *Balanus trigonus* in Careening Bay.

Spirorbis sp. had two distinct settlement peaks (Fig. 6). This suggests that some aspect of the reproductive or settlement processes was inhibited at the maximum and minimum temperatures of the yearly range. Settlement rates may also be influenced by the survival of the free swimming trochophore larvae. Alternatively, two species of *Spirorbis* may have been present, with one species reproducing under the stimulus of cold temperatures and the other during the warm summer months.

Reproductive activity of *Mytilus* was inhibited by high summer temperatures, as gametic development only occurs when the temperature falls below 21°C (Wilson and Hodgkin, 1967). Spawning and spatfall consequently occurred in July when temperatures were at a minimum (Fig. 7e).

The patterns of settlement observed during the first six months of the second year did not coincide with those seen in the first year of the program (Fig. 6). The barnacle *Balanus trigonus* showed an increased settlement, while most of the other species showed reduced recruitment. The increased abundance of barnacle spat may have precluded the settlement of other forms, but it is possible that the settlement of some organisms fluctuates on a two, or three, year cycle rather than annually. The presence of parent stock on nearby surfaces, such as the fouling rig, also has a marked influence on the settlement of organisms on the panels (Lewis, in preparation), and this may have influenced the settlement of organisms in Careening Bay.

The variations observed in the settlement rates from successive years exemplify the need for an extended period of data collection if an accurate understanding of the settlement of fouling organisms at a particular site is to be gained.

4.1.2 *Three-month immersion panels*

The trends in settlement on the three-month panels were similar to those observed on the one-month panels. Some species, such as *Mytilus edulis* and *Balanus trigonus*, were found in much greater numbers on the three-month panels compared to the sum of the one-month panels for the corresponding months (Table 3). The reasons for these differences are discussed below.

The four species found exclusively on the three-month replacement series were represented by only single individuals. The three-month immersion series was not continued beyond the initial twelve months of the program as it did not contribute a significant amount of additional information.

4.2 Community Development

4.2.1 *Stages of development*

The fouling community that developed upon newly immersed surfaces in Careening Bay exhibited the following stages in its progression toward a stable climax community :

(i) Heavy settlement of small opportunistic organisms which matured rapidly.

(ii) Settlement and slow growth of larger organisms which eventually overgrew and smothered the initial colonisers. This overgrowth resulted in the reduced abundances of the early colonisers shown in Figure 7.

(iii) Initial colonisation by errant species which utilised the food and shelter afforded by the larger sessile organisms.

(iv) Intense settlement of *Mytilus edulis* which grew rapidly to cover most of the established fouling. This stage of development occurred eight months after the immersion of the panels, and the mussels grew to an average length of 3 cm in the following ten months. After the initial high settlement, the abundance of mussels on the panel dropped as individuals grew (Fig. 10), which suggests that space may be limiting, and a large number of mussels are physically excluded from the panel.

(v) During summer, the spat of many organisms settled on the larger *Mytilus* and *Anomia* individuals. The abundance of these species, such as *Balanus trigonus* (Fig. 7c), consequently increased.

(vi) The eighteen-month panel showed a marked reduction in abundances for most species (Fig. 7), and several large bare patches were present on each side of the panel. *Mytilus* byssal threads and *Anomia* bases adjacent to these bare patches indicated that some of the population of these species, which had been present in the sixteen-month community, had fallen or been forced out of the fouling community. This fall-off caused the decline in the abundance of the species which had attached to these larger organisms.

Increased predation (Karlson, 1978), or deterioration in water quality, such as an increase in temperature due to thermal discharge (McCain, 1975), would be possible causes of the drop-off. However, no evidence suggested that these factors were present at the time of the change. The decline in abundance was probably due to physical disturbance caused by the affects of Cyclone ALBY which passed over the south of Western Australia in March, 1978.

Mussel spat did not settle on the monthly replacement panels, although spatfall was observed on the three-month immersion panels (Table 3) and on the community development series (Fig. 7e). Experiments have shown that smooth surfaces attract fewer mussel spat when compared to roughened or pitted surfaces (Seed, 1968). In this study, the spat settled on the roughened texture afforded by the established organisms on the development series, but not on the relatively bare one-month immersion panels. A criterion for true biotic succession is that some of the early forms of a community are essential for the establishment of later forms (Shelford, 1930). The absence of *Mytilus* on panels which lack the substrate modification suggests that the settlement of the mussels is a successional process rather than a simple temporal sequence.

4.2.2 *Climax community*

Mytilus edulis and several ascidian and algal species dominate the rock facings and old pilings in Careening Bay (Fremantle Port Authority, 1970-1974). The fouling community seen at the eighteen-month stage is therefore approaching the naturally occurring climax stage of development as observed for the Careening Bay region. The absence of algae from the panel trial was due to the shaded position of the fouling rig beneath the Submarine Wharf. It is therefore not known what effect algae would have on the sequence of development observed in this trial.

4.3 Comparison with Other Regions

The marine fouling community that developed in Careening Bay contained several species that are prevalent in other temperature regions of the Australian coast. The barnacle *Balanus variegatus*, bryozoa *Bugula neritina* and *Cryptosula pallasiana*, and tubeworm *Hydroides norvegica* have been recorded in fouling studies in Hobson's Bay, Victoria and Sydney Harbour, New South Wales (Russ and Wake, 1975; Russ, 1977). The mussel, *Mytilus edulis*, was prominent in Careening Bay and has been similarly observed to dominate the climax community in areas of Sydney Harbour (Wisely, 1959) and Hobson's Bay (Lewis, 1977).

The marked differences observed between fouling at various regions around the Australian coast are indicated by the comparison of the more prominent species found in Careening Bay with those from the east coast sites (Table 2). No one species was a prominent contributor to the fouling community at all sites.

The dry weight of fouling in Careening Bay reached a peak of 3.3 kgm^{-2} of exposed panel surface after sixteen months immersion (Fig. 11). The decline in biomass noted on the eighteen-month panel has been discussed

(Section 4.2). The dry weight during the second year of the trial reached 2.4 kg m^{-2} after six months immersion, which suggests that the biomass of fouling in Careening Bay may be subject to considerable variation dependent upon the year of exposure. Both values however are much less than the 8.3 kg m^{-2} obtained at Garden Island in Sydney Harbour (Russ, 1977). The biomass of fouling in Hobson's Bay, Victoria was reportedly 1.1 kg m^{-2} after twelve months immersion (Russ, 1977), although a present study by Materials Research Laboratories at a nearby site recorded 4.4 kg m^{-2} after six months immersion. These Figures indicate that the biomass of fouling in Careening Bay was also less than that obtained in Hobson's Bay.

5.0 CONCLUSIONS

(1) The settlement of organisms in Careening Bay showed marked seasonal variation. The heaviest settlement of most species occurred during the summer months when water temperatures were highest.

(2) The fouling community developed in several stages with the mussel *Mytilus edulis* the dominant organism on the panels after eighteen months immersion. The mussel-dominated community is typical of the climax community on hard substrata elsewhere in the Careening Bay region.

(3) Some overlap in species composition occurs between the fouling at HMAS STIRLING and temperate sites on the east coast of Australia. However, there is a marked difference in dominant species and therefore the other community characteristics of these sites.

(4) The biomass of fouling in Careening Bay is less than that obtained in Sydney Harbour, New South Wales and Hobson's Bay, Victoria.

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TABLE 1

LIST OF SPECIES FOUND ON FOULING PANELS
IMMERSED IN CAREENING BAY, W.A.

PHYLUM PORIFERA (sponges)

- *Sycon* sp.
- *Clathrina* sp.
- Sponge 3
- Sponge 4

COELENTERATA

- *Obelia* sp. (1)
- *Obelia* sp. (2)
- Hydroid 3
- Hydroid 4

PLATYHELMINTHES

Errant:

- Platyhelminthes sp. 1

ANNELIDA

Errant:

- *Syllis gracilis*
- *Lepidonotus jacksoni*
- *Lepidonotus durbanensis*
- *Polynoinae* sp.
- *Nereis caudata*
- *Ceratonereis* sp.
- *Eunice* sp.
- *Eunice australis*
- *Mystides* sp.
- Syllidae sp.
- *Harmothoe waghi*
- Errant polychaeta 1
- Errant polychaete 2

ANNELIDA

Sedentary:

- **Pomatoceros* sp.
- *Cirriformia filigera*
- *Hydroides* sp.
- *Hydroides norvegica*
- *Hydroides ralumiana*
- *Serpula vermicularis*
- *Salmacina dysteri*
- Spionid sp. 1
- Spionid sp. 2
- *Terebella ehrenbergi*
- *Terebella pterochaeta*
- *Eupolymnia* sp.
- *Thelepes plagiostoma*
- *Spirorbis* sp.
- Sedentary polychaeta 1

ARTHROPODA

Sedentary:

- *Balanus trigonus*
- *Balanus variegatus*

Errant:

- *Munna* sp.
- Caprellidae spp.
- Amphipoda spp.
- Tanaidacea spp.
- Brachyura spp.

TABLE 1

(continued)

MOLLUSCA

- **Chlamys asperrimus*
- *Ostrea* sp.
- *Anomia descripta*
- *Lanistina impacta*
- *Spondulus wrightianus*
- *Hiatella australis*
- *Mytilus edulis*
- *Maculotriton australis*
- Pelecypoda sp. 2

BRYOZOA

- *Bugula flabellata*
- *Bugula stolonifera*
- *Bugula neritina*
- *Tricellaria* sp.
- *Crisia* sp.
- *Watersipora* sp.
- *Watersipora subovoidea*
- *Schizoporella unicornis*
- *Microporella cornuta*
- *Cryptosula pallasiana*
- *Rhamphostomella* sp.
- *Barentsia gracilis*
- *Aetea truncata*
- *Bowerbankia imbricata*

ECHINODERMATA

- *Crinoid sp. 1

CHORDATA

ASCIDIACEA:

- *Styela plicata*
- *Styela irma*
- *Ciona intestinalis*
- *Microcosmus* sp.
- *Molgula* sp. (1)
- *Molgula* sp. (2)
- *Ascidia* sp.
- Solitary ascidian 1
- *Perophora* sp.
- *Trididemnum* sp.
- *Botrylloides leachii*
- *Botryllus schlosseri*
- *Symplegma viride*
- Compound ascidian 1
- Compound ascidian 2
- Compound ascidian 3

* Species found only on 3-month immersion panels (Y-series)

T A B L E 2

COMPARISON OF PRINCIPAL ANIMAL FOULING SPECIES

AT THREE NAVAL ESTABLISHMENTS

	HMAS Stirling	Garden Island Naval Dockyard	Williamstown Naval Dockyard
Barnacles	*Balanus trigonus*	*Balanus variegatus*	*Balanus variegatus* *Elminius modestus*
Ascidians	*Microcosmus* sp. *Styela irma*	*Pyura stolonifera*	*Ciona intestinalis*
Molluscs	*Anomia descripta* *Mytilus edulis*		*Mytilus edulis*
Bryozoa	*Rhamphostomella* sp. *Bugula stolonifera* *Tricellaria* sp.	*Watersipora subovoidea* *Bugula neritina* *Schizoporella unicornis*	*Bugula neritina* *Cryptosula pallasiana*

TABLE 3

SETTLEMENT COUNTS OF FOULING ORGANISMS ON 3 MONTH IMMERSION PANELS AND CORRESPONDING ONE MONTH IMMERSION PANELS

Species	Panels					
	Y2	J4, J5	Y3	J6, J7, J8	Y4	J9, J10, J11
Balanus trigonus	54	51	151	25	22	7
Bugula stolonifera	104	140	25	69	1	15
Tricellaria sp.	6	6	6	3	1	1
Mytilus edulis	-	-	20	1	14	6
Spirorbis sp.	246	375	241	179	550	288
Salmacina dysteri	16	13	37	31	1	2
Clathrina sp.	30	25	38	4	11	2
Anomia descripta	2	1	1	-	2	-

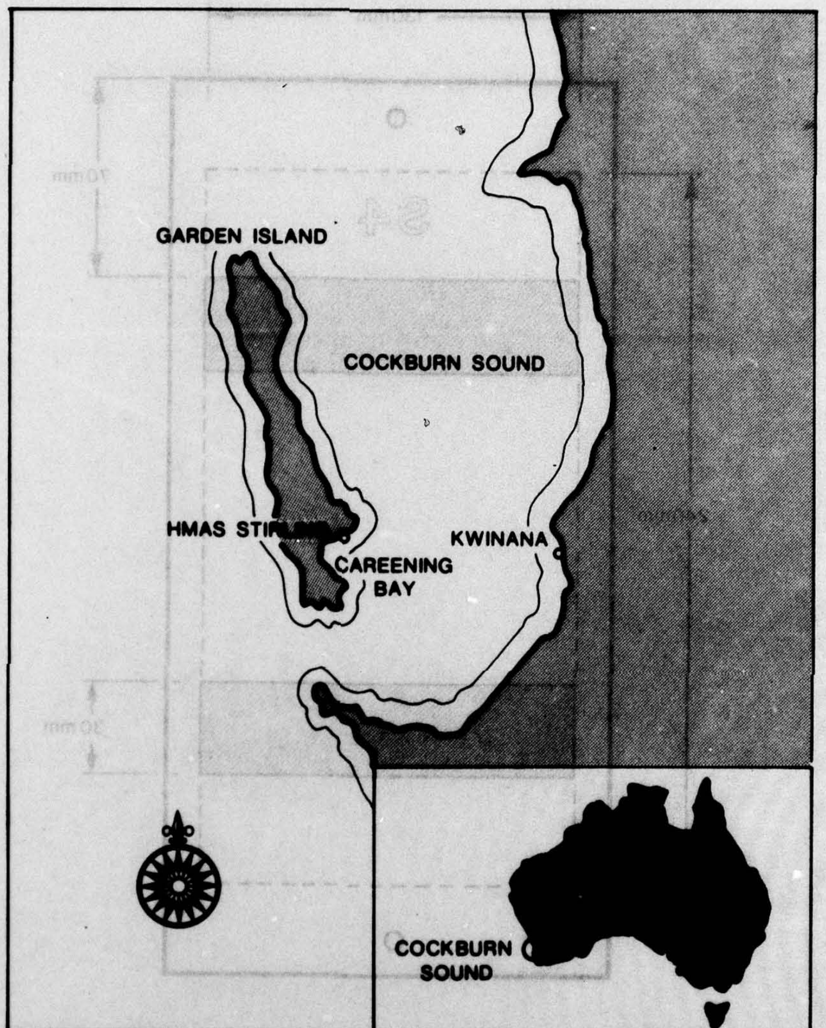


FIG. 1 - Locality diagram.

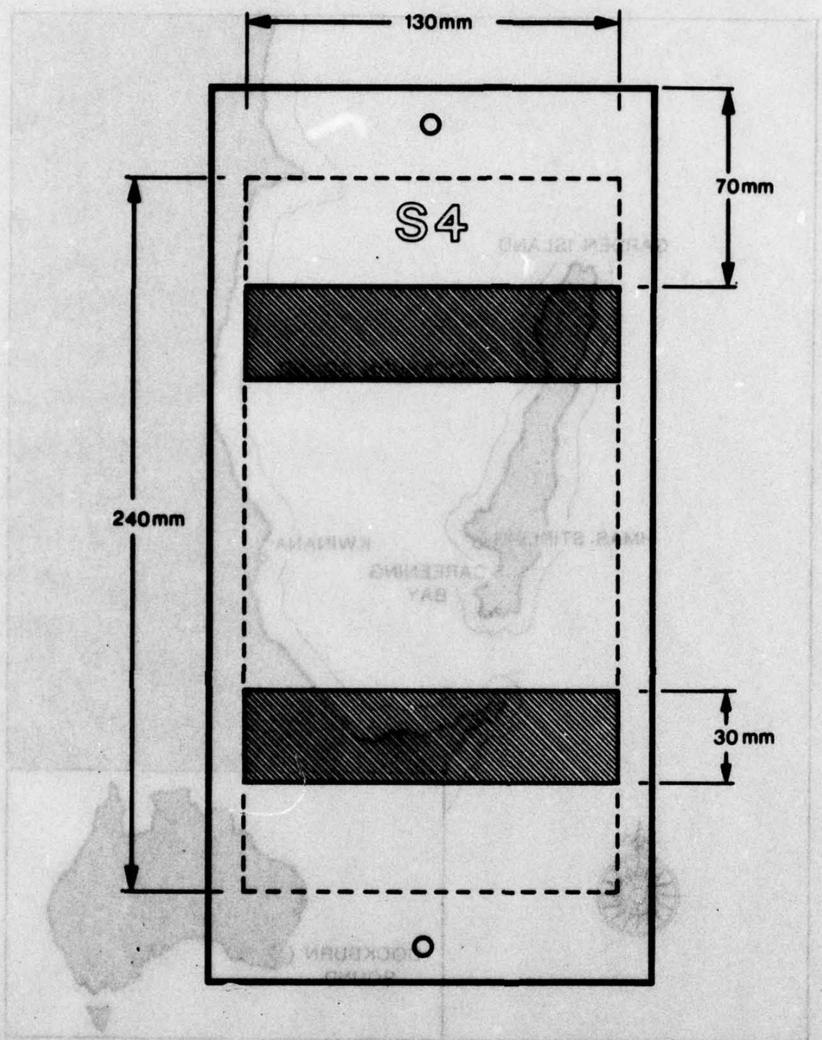


FIG. 2 - Exposure panel showing areas of assessment.

Hatched area - transects for density counts.
Area inside broken line used for percentage cover estimates.

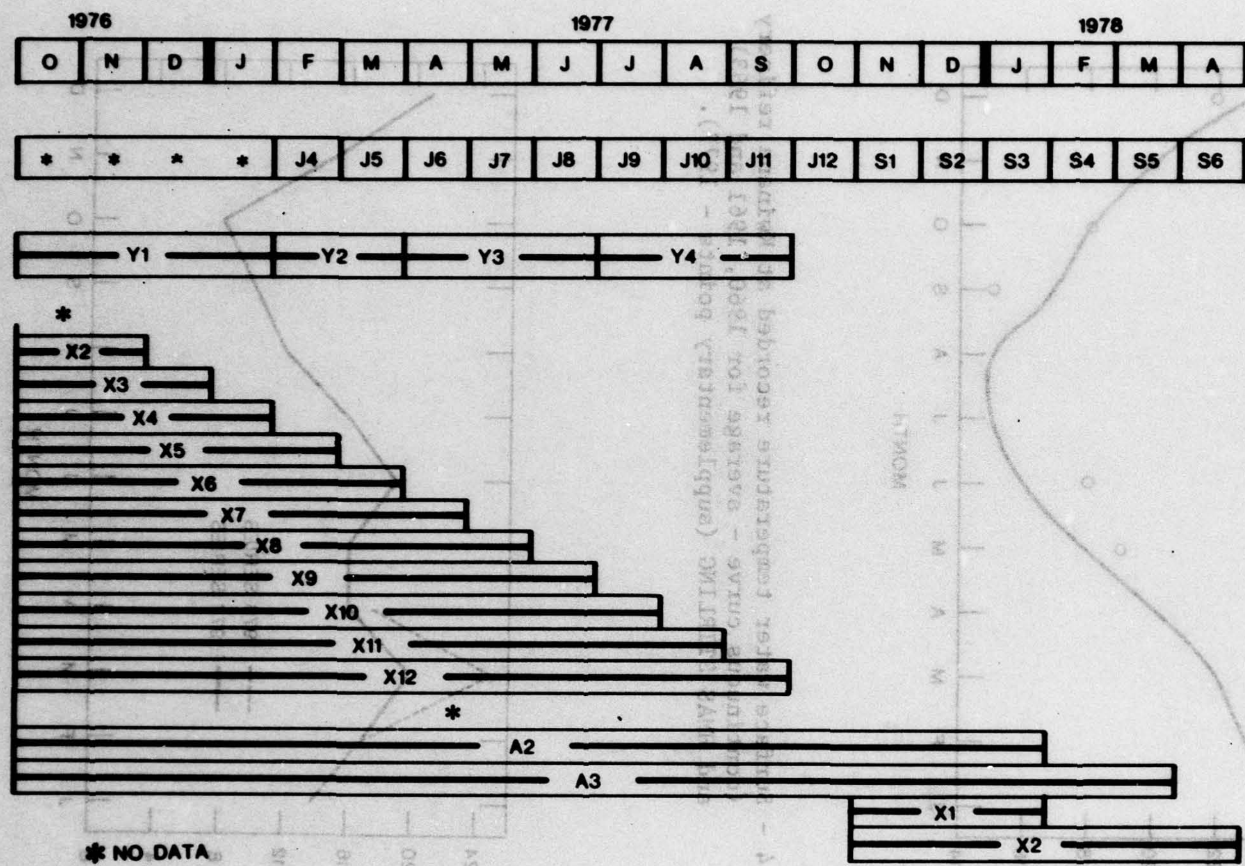


FIG. 3 - Period of immersion of experimental panels.

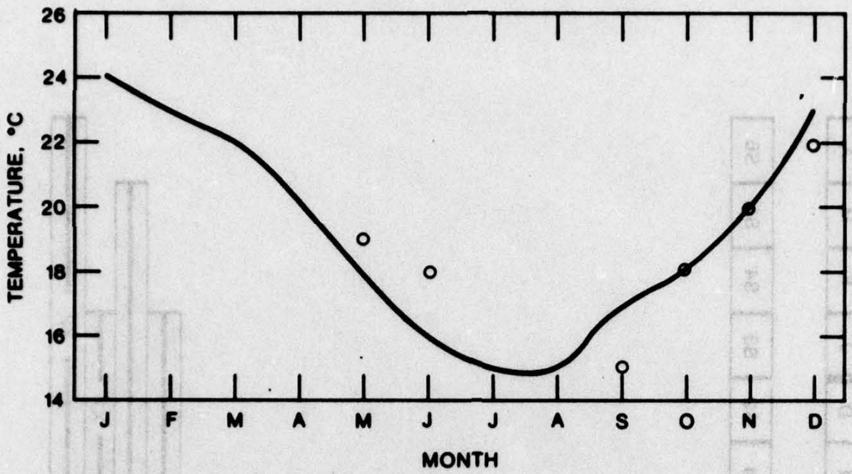


FIG. 4 - Surface water temperature recorded at Kwinana refinery (continuous curve - average for 1960, 1961 and 1963) and HMAS STIRLING (supplementary points - 1977).

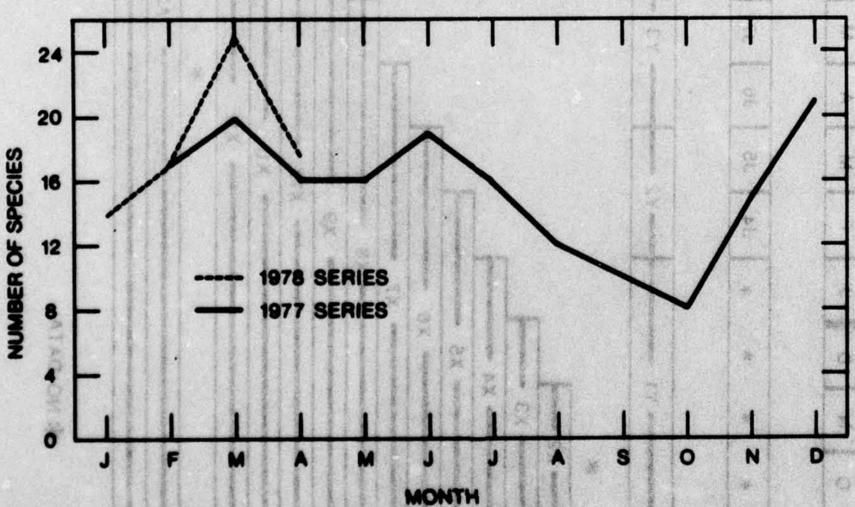


FIG. 5 - Number of sedentary species on monthly immersion panels.

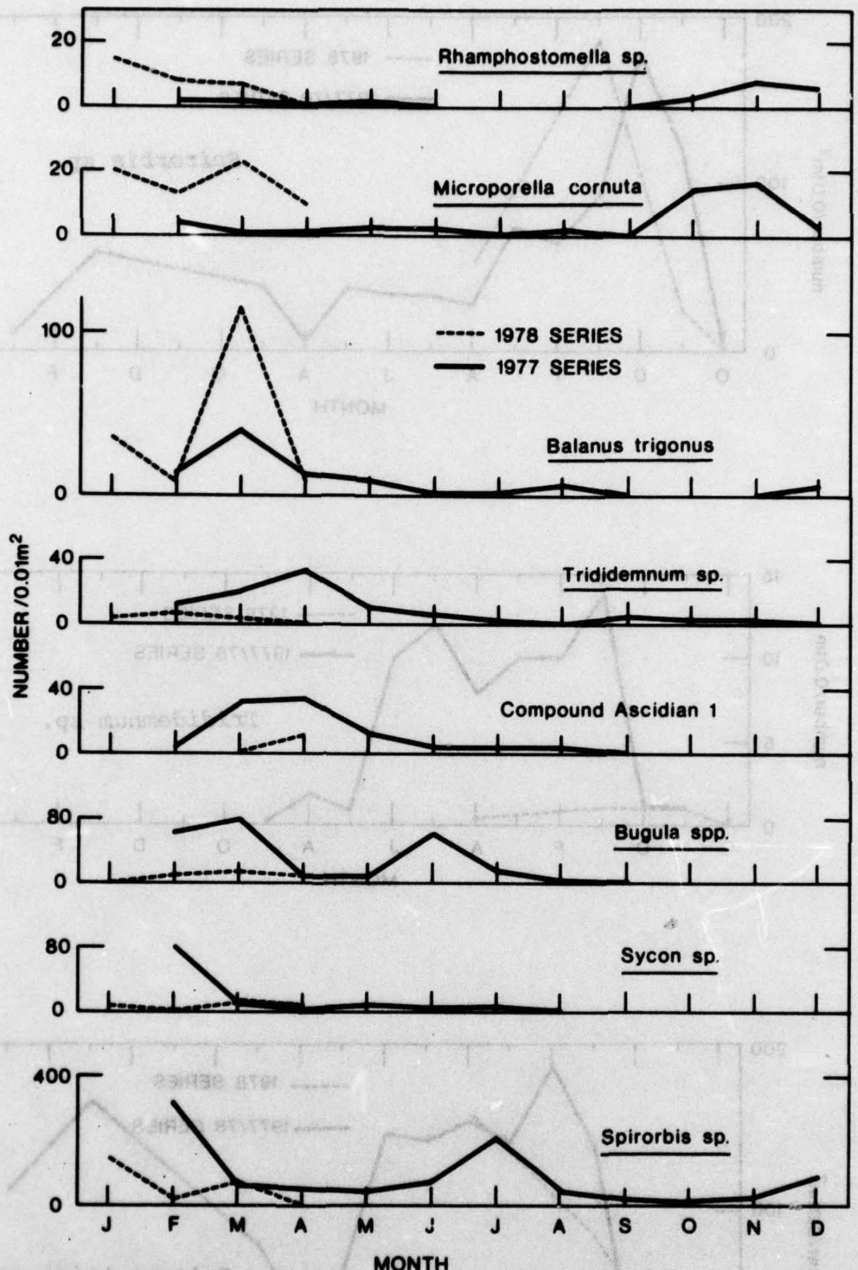
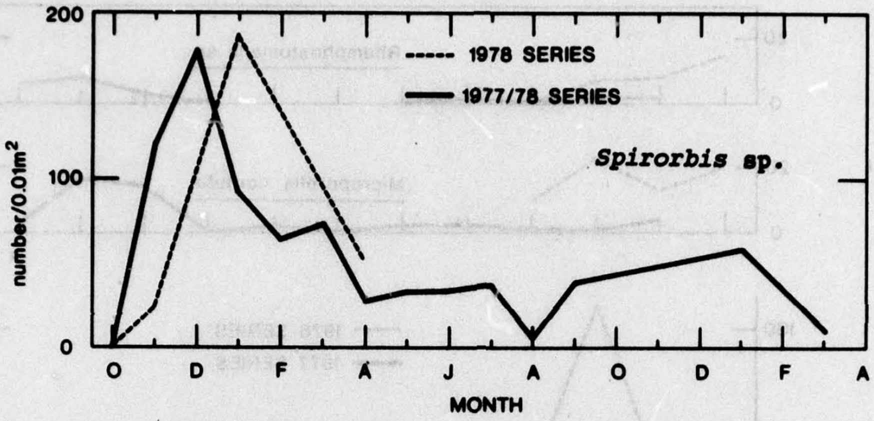


FIG. 6 - Seasonal variation in settlement of principal fouling organisms in Careening Bay.



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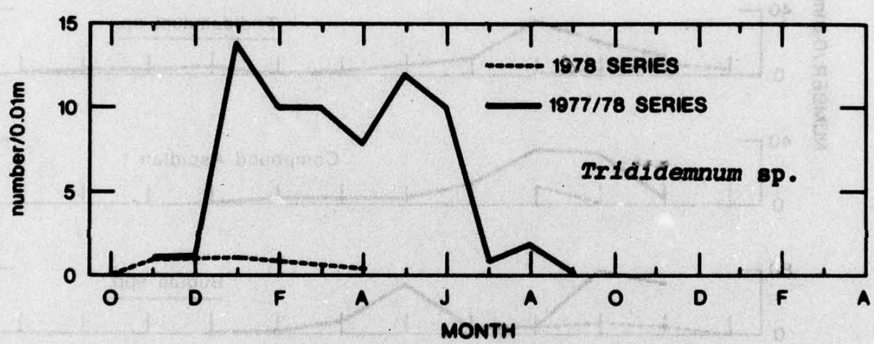

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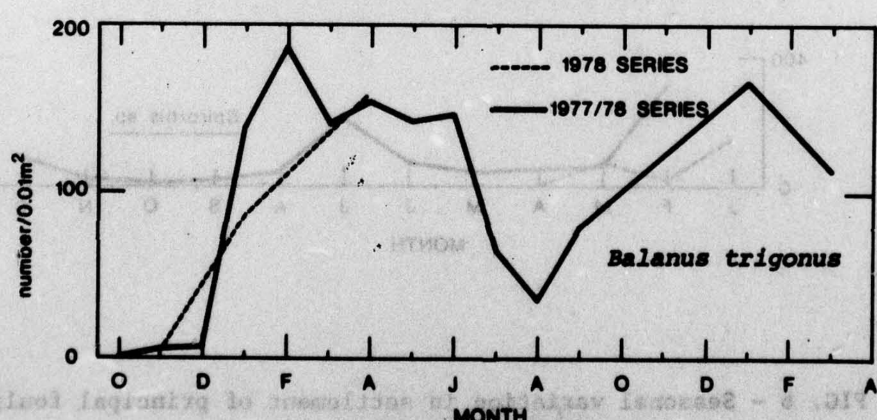

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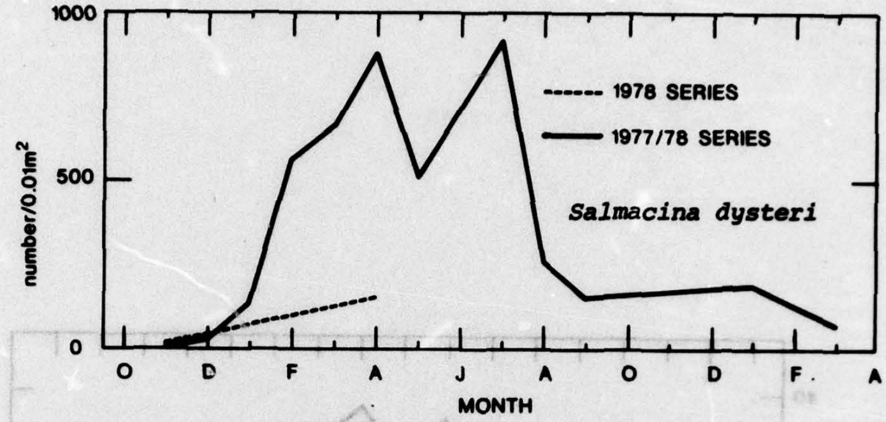
FIG. 7 - Changes in abundance of dominant animal fouling organisms on community development panel series with time.



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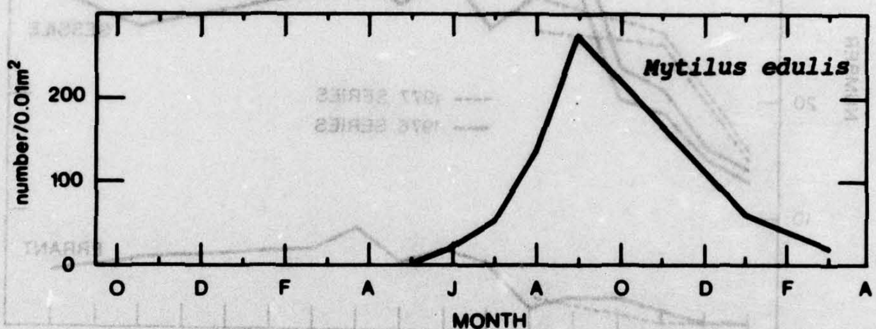

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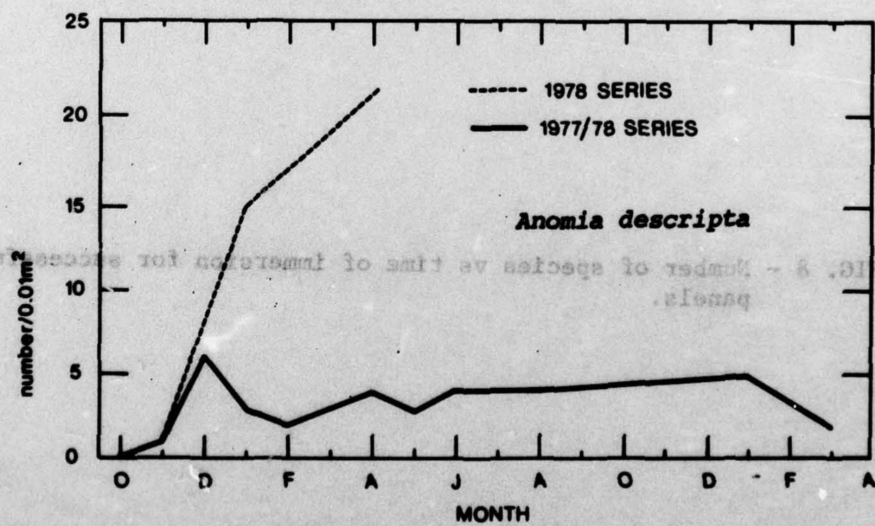

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FIG. 7 (Continued)

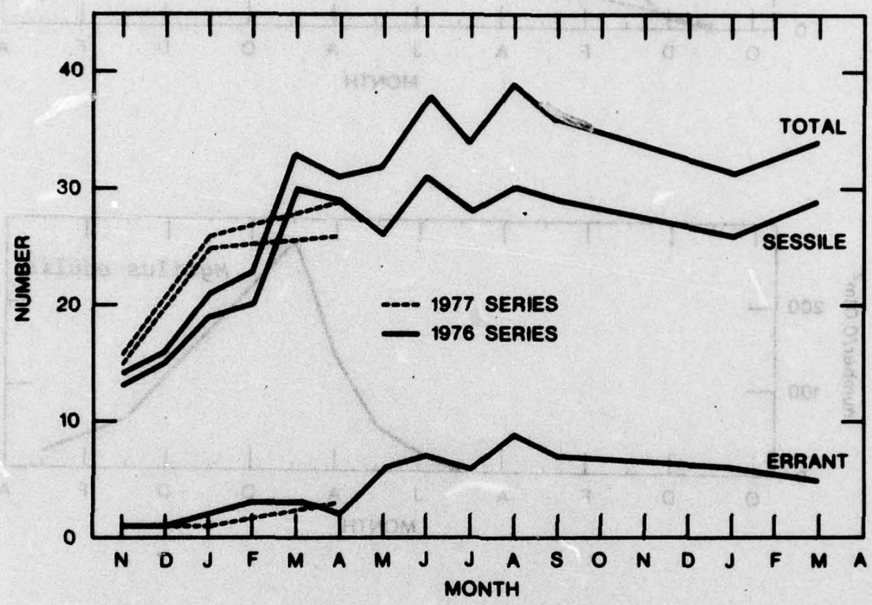

FIG. 8 - Number of species vs time of immersion for successful panels.

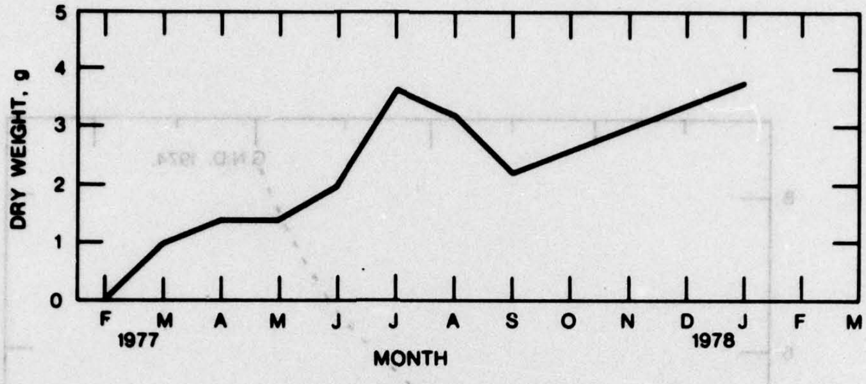

FIG. 9 - Changes in average dry weight of *Anomia* individuals with time.

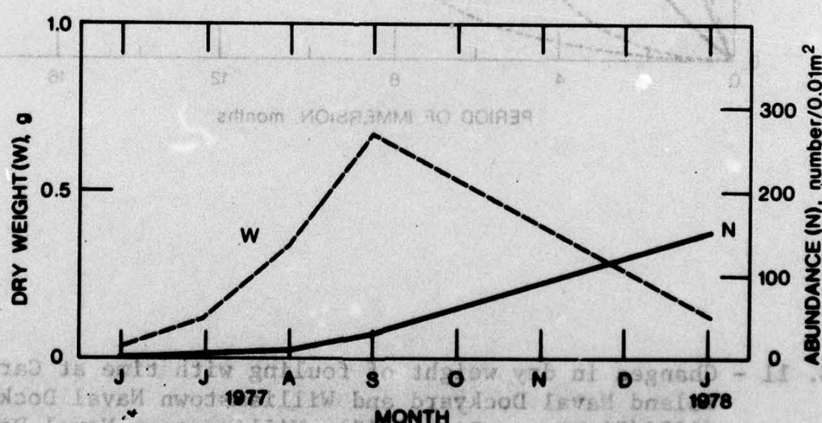

FIG. 10 - Change in dry weight of *Mytilus* individuals with time.

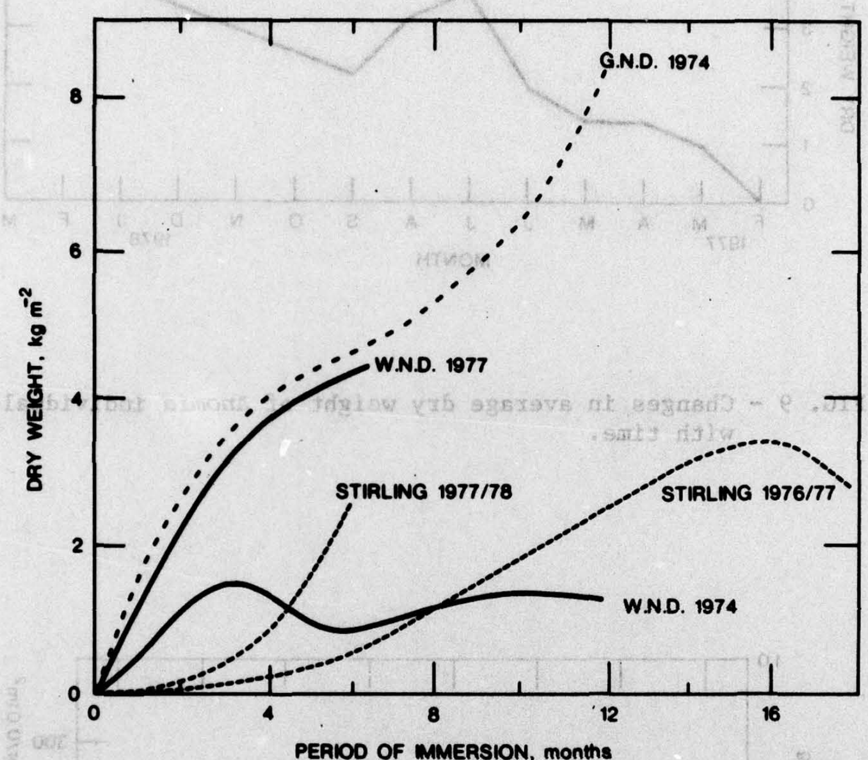

FIG. 11 - Changes in dry weight of fouling with time at Garden Island Naval Dockyard and Williamstown Naval Dockyard (1973/74 Data - Russ 1977), Williamstown Naval Dockyard (1977/78), and HMAS STIRLING.

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